SUMMARY

PURPOSE AND BACKGROUND

The Bureau of Reclamation's Yakima Project provides irrigation water for a comparatively narrow strip of fertile land that extends for 175 miles on both sides of the Yakima river in south-central Washington. The irrigable lands eligible for service from Reclamation total about 465,000 acres. Major storage dams and reservoirs on the Project are Keechelus, Kachess, Cle Elum, Bumping Lake, and Tieton Dam (Rimrock Lake). There are no upstream or downstream fish passage facilities at any of these storage dams.

The historical lakes and tributaries upstream from these dams formerly supported runs of anadromous salmonids and resident species of fish. Varying amounts and quality of potential spawning and rearing habitat suitable for anadromous salmon and steelhead trout still exist above the dams. Two species listed under the Endangered Species Act (ESA) — bull trout and Middle Columbia River steelhead — would likely benefit from passage at the dams. Passage would also likely benefit chinook salmon and might allow reintroduction of extirpated sockeye salmon and coho salmon.

Early in 2001, many Yakima Basin interests viewed the proposed Keechelus Safety of Dams (SOD) construction as an opportunity to add fish passage at Keechelus Dam. These interests strongly urged Reclamation to incorporate fish passage features at Keechelus Dam as part of the SOD construction. Reclamation carefully considered this issue but was unable to build passage features as part of the Keechelus SOD construction. However, in response to the stated concerns, Reclamation negotiated a "mitigation agreement" with Washington Department of Fish and Wildlife (WDFW) and agreed to certain conditions contained in the Hydraulic Project Approval (HPA) permit for the Keechelus Safety of Dams construction.

To meet the requirements of the HPA, Reclamation began this preliminary assessment of fish passage at all the storage dams of the Yakima Project and is seeking funding for detailed feasibility studies that may eventually lead to implementation of fish passage features at the dams. The purpose of this "Phase I assessment" is to consolidate and document existing habitat information, evaluate preliminary passage concepts, prepare appraisal-level cost estimates for passage options, and identify uncertainties associated with fish passage at the dams where more data and modeling are needed to determine the relative merits of passage.

A core team of technical specialists from Reclamation's Pacific Northwest Regional Office and Upper Columbia Area Office prepared this assessment. Other technical specialists representing

local, State, and Federal agencies, irrigation districts, and other entities provided extensive support for this effort and helped to shape the contents of this report. However, the opinions, assumptions, observations, conclusions, and recommendations are those of Reclamation and do not necessarily represent the opinions or thoughts of the other participants.

KEECHELUS SOD ANALYSIS

As required by the HPA, initial study efforts of the Phase I assessment were directed towards review and evaluation of potential fish passage features at Keechelus Dam and the relationship of those features to the on-going SOD reconstruction activities. This review and evaluation confirmed Reclamation's earlier decision to move ahead with the SOD reconstruction while continuing the investigation of the feasibility of providing fish passage features at Keechelus Dam and the other Project storage dams.

Through this review and evaluation, Reclamation determined that there would be no significant savings achieved by incorporating fish passage features into the SOD reconstruction as opposed to retrofitting fish passage at a later date. The SOD work will not adversely affect the options for constructing fish passage facilities, nor make the construction of fish passage facilities in the future more expensive or more difficult to construct. There would be no financial or operational advantage to starting passage construction during or in conjunction with current SOD work.

OPERATIONS AND STORAGE FACILITIES

Reclamation tailors its operations to ensure that public safety requirements are satisfied (flood control and recreational use), that water delivery contractual obligations are met (irrigation and M&I), and that instream flow targets (fish and wildlife habitat) are met. Maximizing flood control, irrigation water delivery, and meeting target streamflows requires continuous water management adjustments and includes many system operation considerations.

The five major Project reservoirs are operated in a coordinated manner to provide for the needs of the system as a whole. The releases from each reservoir are balanced to meet system-wide irrigation and water demands in conjunction with natural runoff and return flow available in the basin. No single reservoir is designated to supply the needs of one particular area, irrigation district, or Project division.

FISHERIES AND FISH PASSAGE CONSIDERATIONS

The four natural lakes (Tieton Dam was built on the open river) supported Native American fisheries for sockeye salmon and other anadromous and resident fish. Detailed information is not available for pre-Project fish populations in these lakes. However, available information suggests that all of

the native species currently found in each lake — as well as those found in the river reach downstream from each dam — were historically present in the watersheds above the dams. In addition, sockeye salmon and coho salmon were present but are now extinct. Rimrock Reservoir was not a natural lake so the watershed upstream would not have supported sockeye salmon; however, it is likely the river and its tributaries would have been used by the other anadromous species.

There are peak migration periods for juvenile downstream migrants generally during the spring and fall. However, there is some movement of juveniles nearly year-round. The upstream migration period for the combination of different species of adult salmonids could extend from March through November. Because of the number of salmonid species that would eventually be involved in restoration and the different expressions of their life histories, it is reasonable to assume that fish would be present and trying to move past the dams nearly year-round at all five storage projects.

Providing fish passage at Yakima River basin storage projects could increase or enhance populations of Upper Yakima Basin steelhead, coho salmon, and spring chinook salmon by restoring access to historically occupied habitat; restoring life history and genetic diversity of salmonids; allowing reintroduction of sockeye salmon back into the watersheds where they occurred historically; and reconnecting isolated populations of bull trout and other resident fish species. Over time, anadromous salmonids would be expected to recolonize the watersheds upstream from the storage dams if fish passage were provided.

Bull trout abundance would be expected to expand due to enhanced connectivity and interaction among the presently isolated populations, and expanded foraging and overwintering habitat. Restoring connectivity among presently isolated populations of bull trout would allow for dispersal of fish among local populations, providing a mechanism for supporting weaker populations or refounding those that might become extirpated. It will also allow for gene flow among populations, which prevents the loss of genetic variation that insures survival in variable environments and thus decreases the probability of local extirpations.

TRIBUTARY HABITAT CONDITIONS

The core team assessed tributary habitat conditions upstream of the storage reservoirs. The team also considered the potential for improving connectivity among populations of native fish. The team obtained tributary stream length in miles up to natural or manmade barriers from various published reports and USFS stream surveys. The team estimated, where possible, the additional length of tributary stream that might be available if manmade barriers to fish passage, such as improperly placed culverts or other obstructions, were replaced and/or improved to allow fish passage.

The fisheries subteam used existing data and information to assess tributary habitat. The subteam attempted a qualitative evaluation of the spawning and rearing habitat in the tributary streams. The data were collected from various agency reports and peer-reviewed papers, on-the-ground

observations, and experiences of the team participants. Information relating to spawning and rearing habitat for anadromous salmonids was not uniform for all tributary streams, so comparison among tributary streams was not possible. For this preliminary assessment, the subteam assumed that on a scale of from excellent to poor, the newly accessible habitat would be "good" overall for successful spawning and rearing in all basins. The team did not attempt to calculate potential increases or changes in anadromous salmonid production as a result of habitat expansion upstream from reservoirs.

Estimated overall reservoir tributary stream length in miles of suitable spawning and rearing habitat that would be potentially accessible to anadromous salmonids if passage were provided at the several dams is shown in Table 5-1 in the main narrative of the report on page 32.

PASSAGE CONCEPTS AND COSTS

In general, fish passage at each of these dams is complicated by the large fluctuation of reservoir water surface elevations. Typically, the reservoirs begin to fill at the start of the water year (October), reach maximum water surface elevation in the spring (at the start of the irrigation season), and are drawn down through the remainder of the year. Depending on the reservoir, the annual difference in elevation can be as much as 120 feet. Under these conditions, a traditional gravity flow fish ladder would not function.

The passage concepts in this report describe means of providing fish passage that is exacerbated by the problem of high water surface elevation fluctuations. Some concepts would provide fish passage over the entire range of elevations. Others would be designed to operate over a specific and more limited range of elevations that would result in shorter time periods when passage could be provided.

In developing new fish passage operations and structures at Project storage reservoirs, the winter hydrology and/or conditions under which these facilities would need to operate must be carefully considered. All of the storage reservoirs have frozen-over solid at times in the past. In many years, this layer of ice will support light vehicle traffic and in most years the snowpack which can be as much as 8 feet deep in the early spring at some sites. The cold, snowy conditions will not necessarily preclude the development of fish passage at the dams; however, when designing and installing fish passage features, the winter conditions and associated impacts on operations and maintenance (O&M) activities must be taken into account.

The methods for providing upstream passage for anadromous salmonids examined in this report include trap-and-haul, fish ladder with pumped flow, and a traditional fish ladder. The **trap-and-haul** is a conventional but labor intensive method that has been used in the past. Fish swimming upstream are attracted into a collection facility where they can be captured and then transported over the dam, usually by trucks equipped with tanks and water-quality equipment. The **fish ladder with**

pumped flow concept uses a traditional fish ladder to the top of the dam and a flume (slide) that slopes down to the reservoir. Ladder flow is pumped from the river to the top of the dam. A **traditional fish ladder** concept, a series of stepped pools and gravity flow in the ladder, may be feasible at Bumping Lake Dam.

The methods for providing downstream fish passage examined in this Phase 1 assessment include surface spill with modification to the existing spillway, construction of new spillways, use of a fish collection barge, and construction of new outlet works.

Several concepts at each dam involve **spillway modification** for downstream passage through the use of "overshot gates," which operate by spill over the top. The **new fish spillway** concept operates under the same principle as the surface spill with overshot gates. The idea of this concept is to provide surface-spill releases at lower reservoir elevations than could be obtained by modifications to the existing spillways.

The **fish collection barge** concept consists of a barrier net (to guide fish), a collection (or "gulper") barge with pumps, an underwater bypass pipe, and a holding (or "trap") barge. The concept was modeled after existing facilities at Upper Baker Dam on the Baker River in western Washington (owned by Puget Sound Energy). The **new outlet works** concept is a stationary collection structure that provides an attraction flow to draw downstream migrants to the structure. Fish are separated from the attraction flow by a screen and are then transferred with a bypass flow that moves them into a collection chamber. From there, they are moved below the dam by one of two methods; either through a pipe or a trap-and-haul system.

The following estimated costs are typical for each site. Construction costs for upstream fish passage features are estimated at $7 million for the **trap-and-haul** concept, $8.5 million for the **fish ladder with pumped flow** concept, and $11 million for the traditional **fish ladder** concept. Annual O&M costs could range from$250,000 (trap-and-haul) to $380,000 (ladder with pumped flow). O&M costs for the traditional ladder would be relatively minor.

Construction costs for downstream passage features are estimated from $1.7 million to $5 million for the **spillway modifications** concept; $4.6 million to $42 million for the **new spillway** concept; $11 million for the **fish collection barge** concept; and $20 to $25 million for the **new outlet works** concept. Annual O&M costs for the surface spill concepts would be relatively minor. Annual O&M costs for the fish collection barge would be about $340,000 and for the new outlet works, about $320,000.

FINDINGS

During this Phase I assessment process, we determined that there are a range of options and opportunities for providing fish passage and eventually reestablishing populations of anadromous salmonids in some tributaries of the five Yakima River basin reservoirs. Some combinations of

passage options and associated biological benefits are more feasible than others. Costs vary widely among options, especially for downstream passage of juvenile fish. All five reservoirs have some tributary habitat that would be available if passage were provided at the dams; the amount and quality of the habitat varies considerably from reservoir to reservoir.

From our initial assessment, it appears that some form of upstream and downstream passage for anadromous salmonids and bull trout connectivity is technically feasible at all the storage projects. Passage at some would be much more expensive in relation to available habitat than at other locations. Tables 8-1, 8-2, and 8-3 in the main body of the report on page 58 were developed to relate the number of stream miles of habitat to the cost of fish passage at each site. This provides a way to make a rough comparison of the relative merits of providing passage at each of the sites.

The estimated costs of the several upstream and downstream passage options were divided by the number of stream miles of newly accessible habitat. This determined the cost per mile of habitat for each upstream and downstream passage option at each storage project. These values were then combined to show the cost per mile of newly accessible habitat for the different combinations of upstream and downstream passage features. Costs per mile of stream habitat for upstream passage options range from $0.2 million to $3.6 million. Costs per mile of stream habitat for downstream passage options range from $0.1 million to $10.6 million.

Not reflected in the table is the downstream migrant passage window that each of the options would encompass. The hydrographs for the five reservoirs (figures 1 through 5 in appendix D) show that each option provides a different window of passage. For example, at Cle Elum Dam, a new spillway would provide a much broader window of passage than spillway modification, but at a higher cost. In drier years such as 2001, a new spillway still would not provide for season-long, volitional, juvenile fish passage.

Table 8-3 shows that for all storage projects, the lowest initial cost per mile of newly accessible habitat (that is, without considering passage window size or O&M costs) for anadromous salmonids is trap-and-haul for adult upstream passage and spillway modification for juvenile downstream passage.

ADDITIONAL ISSUES AND CONCERNS

The team encountered numerous issues and concerns that were beyond the scope of this Phase I assessment. These issues and concerns as well as identified data gaps will need to be addressed in later phases of this effort. As a followup to this final Phase I report, Reclamation will draft a Phase II proposal to provide the context for discussion by the entire assessment team in early spring 2003.

CONCLUSIONS

- **There are definite benefits to restoring fish passage at Yakima Project storage dams.**
- **It is technically feasible to construct fish passage facilities at all five Yakima Project storage dams.**
- **Longer passage windows would provide the greatest biological benefits for migratory species.**
- **Suitable habitat is available for anadromous and resident salmonids in the tributaries above the dams.**
- **It is likely that self-sustaining populations of anadromous salmonids and bull trout connectivity could be restored if passage is provided.**

RECOMMENDATIONS

- **Contingent upon available funding, evaluate two reservoirs in greater detail in Phase II.**
- **Contingent upon funding, continue in Phase II to evaluate tributary habitat initiated in Phase I.**
- **Plan for operational adjustments**
- **Evaluate potential operational changes, including new basin storage, to determine possible benefits to fish passage.**
- **Monitor results of passage and restoration activities and institute an adaptive management approach as part of Phase III.**
- **As part of Phase II efforts, develop a detailed scope of work for Phase III and later stages of the feasibility study in collaboration with other entities and organizations involved with fish passage and recovery issues in the Yakima River basin.**